



SEKOLAH SISWAZAH  
(GRADUATE SCHOOL)  
UNIVERSITI UTARA MALAYSIA

PERAKUAN KERJA/TESIS  
(Certification of Thesis Work)

Kami, yang bertandatangan, memperakukan bahawa  
(I, the undersigned, certify that)

**IDA HARLINA IKHWAN NASIR**

calon untuk Ijazah  
(candidate for the degree of) **SARJANA SAINS (TEKNOLOGI MAKLUMAT)**

telah mengemukakan tesis/disertasinya yang bertajuk  
(has presented his/her project paper of the following title)

**USING SIMULATION TO EVALUATE THE PERFORMANCE  
OF INTERNET PAYMENT SYSTEM: A CASE STUDY ON CYBANK**

seperti yang tercatat di muka surat tajuk dan kulit tesis/disertasi  
(as it appears on the title page and front cover of project paper)

bahasa tesis/disertasi tersebut boleh diterima dari segi bentuk serta kandungan, dan liputan bidang ilmu yang memuaskan, sebagaimana yang ditunjukkan oleh calon dalam ujian lisan yang diadakan pada :

(that the thesis/dissertation is acceptable in form and content, and that a satisfactory knowledge of the field covered by the thesis was demonstrated by the candidate through an oral examination held on **18 OGOS 2002**

Pengerusi Viva (Chairman for Viva)	: Prof. Madya Dr. Zulkhairi Md. Dahalin	Tandatangan: (Signature)	
---------------------------------------	--	-----------------------------	--

Penilai Luar (External Assessor)	: Prof. Madya Dr. Illias Mamat	Tandatangan: (Signature)	
-------------------------------------	-----------------------------------	-----------------------------	--

Penilai Dalam (Internal Assessor)	: Prof. Madya Dr. Ku Ruhana Ku Mahamud	Tandatangan: (Signature)	
--------------------------------------	---	-----------------------------	--

Penyelia Utama (Principal Supervisor)	: Prof. Madya Dr. Razman Mat Tahar	Tandatangan: (Signature)	
--	---------------------------------------	-----------------------------	--

Dekan Sek. Siswazah: (Dean Graduate School)	Prof. Dr. Juhary Hj. Ali	Tandatangan: (Signature)	
--	-----------------------------	-----------------------------	--

Tarikh : **18 Ogos 2002**  
(Date)

## **PERMISSION TO USE**

In presenting this thesis as major requirements for a post-graduate degree from University Utara Malaysia, I agree that the University Library may make it freely available for inspection after being submitted for a year. I further agree that permission for copying of this thesis in any manner, in whole or in part, for scholarly purposes may be granted by my supervisor or, in his absence, by the Dean of the Graduate School. It is understood that any copying or publication or use of this thesis or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that recognition shall be given to me and to Universiti Utara Malaysia for any scholarly use, which may be made of any material from my thesis.

Request for permission to copy or to make other use of materials in this thesis, in whole or in part, should be addressed to:

Dean of Graduate School

Universiti Utara Malaysia

06010 Sintok

Kedah Darul Aman

MALAYSIA

## **ABSTRAK**

Sistem Pembayaran Menerusi Internet (IPS) merupakan kaedah terkini bagi mengendalikan transaksi kewangan menerusi Internet. Penggunaannya yang dikatakan tidak efektif telah banyak dibincangkan oleh pelbagai pihak bersama andaian-andaian tentatif. Oleh itu, aspek pertama kajian ini telah disasarkan untuk mengenalpasti masalah dan punca penggunaan yang tidak efektif itu. Hasil kajian mendapati masalah tersebut berpunca dari pengambilan masa yang lama untuk menyudahkan sesuatu transaksi. Beberapa langkah peningkatan prestasi telah dikenalpasti dan pengurusan Cybank perlu membuat perubahan tersebut bagi menarik minat penggunaanya. Ini adalah selaras dengan visi pengurusan Cybank yang mahukan Cybank berada di tangga teratas dalam industri IPS. Aspek kedua kajian ini pula merangkumi penggunaan kaedah simulasi yang digunakan untuk memodelkan gelagat operasi Cybank. Teknik ini didapati sangat efektif dalam memodelkan sistem yang begitu kompleks seperti IPS. Teknik ini seterusnya berjaya mencadangkan beberapa perubahan jitu yang patut dibuat ke atas sistem Cybank berdasarkan hasil kuantitatif yang dijana dari kajian ke atas model yang telah dibina.

**Katakunci:** *Sistem Pembayaran Menerusi Internet, Cybank, Tinjauan Prestasi, Simulasi, Eksperimentasi Model*

## **ABSTRACT**

The Internet Payment System (IPS) is the latest means of doing financial transactions over the Internet. However, its inefficient usage among Internet users has become a prime discussion among many folks and many tentative assumptions were made. Hence, the first aspect of this research was aimed to identify problems and reasons that caused this hindrance. The result indicated the time-consuming factor to process real-time requests, as one of its main deficiency. A few performance enhancement approaches were recognized and Cybank's management was stimulated to counter those predicaments in order to excite its current and potential users in employing Cybank. This is in line with Cybank's vision, which is to be a world class IPS supplier in the IPS industry. The second aspect of this research covered the use of simulation in modeling the operational behavior of Cybank. It has been proven that this technique is very effective in modeling such complex systems like the IPS. The simulation technique has also succeeded in recommending appropriate and sound changes that could be implemented on Cybank, based on the quantitative result acquired from experiments performed on the built model.

**Keyword:** *Internet Payment System, Cybank, Performance Survey, Simulation, Model Experimentation*



## ACKNOWLEDGEMENT

In the name of Allah, the Most Gracious and the Most Merciful.

I would like to express my sincere gratitude and credit to:

- ◆ The Ministry of Science, Technology and Environment for the scholarship
- ◆ University Utara Malaysia for the well-equipped resources, facilities and excellent professionalism especially by the Graduate School staff, the School of Information Technology's staff and the School of Quantitative Science's staff.
- ◆ My idealistic and tolerant supervisor, Assoc. Prof. Dr. Razman Mat Tahar for his motivation and structured guidance in introducing me to this challenging and rapidly emerging, field of decision support.
- ◆ The Dean of School of Information Technology, Assoc. Prof. Dr. Zulkhairi Md. Dahalin. The Deputy Deans, Mr. Roslan Jamaludin, Assoc. Prof. Aziz Romli and my ex-Dean, Prof. Abu Talib Othman.
- ◆ YB Dato' Kamal Hussain, his family, Mr. Bob Delaney and all Cybank staff for the priceless information, co-operation and support.
- ◆ My dearest husband, Jafni Zainal for his genuine love, extensive support and endurance. My late father, my beloved mom Wan Haslah, my inspiring sisters, Haslin, Huda, Raha, Hani and Nora as well as my whole family and relatives; for the authentic encouragement.
- ◆ Lecturers and research colleagues who helped to strengthen this research.
- ◆ Lastly all the individuals involved in the development of this research such as Jessica and Aini.

## **TABLE OF CONTENTS**

ABSTRAK	i
ABSTRACT	ii
ACKNOWLEDGEMENT	iii
TABLE OF CONTENTS	iv-x
LIST OF FIGURES	xi
LIST OF TABLES	xii
LIST OF APPENDIX	xiii

### **CHAPTER 1: INTRODUCTION**

1.1	Background	1
1.2	Problem Statement	2
1.3	Objectives	3
1.4	Method of Analysis	3
1.5	Scope of Research	5
1.6	Significance of Study	7
1.7	Thesis Outline	7
1.8	Conclusion	8

### **CHAPTER 2: MODELING AN INTERNET PAYMENT SYSTEM**

2.1	Introduction	10
2.2	Internet Technology	11

2.3	Internet Payment System	12
2.3.1.	Entities in the IPS Industry	14
2.3.2.	IPS System Operation	16
2.3.3.	Major Players in the IPS Industry	17
2.3.4.	Benefits of IPS	18
2.4	High Performance	20
2.4.1.	Performance Evaluation	21
2.4.2.	Performance Variables	22
2.4.3.	Performance Evaluation Technique	23
2.4.3.1.	Deterministic Evaluation Technique	23
2.4.3.2.	Stochastic Modeling Technique	23
2.5	Simulation Modeling Technique	25
2.5.1.	Definition of Simulation	26
2.5.2.	Purpose of Simulation	27
2.5.3.	Advantages and Disadvantages of Simulation	29
2.5.4.	Simulation Capabilities and Limitations	29
2.5.5.	Application of Simulation in Related Fields	30
2.6	Conclusion	32

### **CHAPTER 3: CYBANK'S OPERATION AND ITS PERFORMANCE**

3.1	Introduction	33
3.2	Cybank's Background	33
3.2.1.	Semi-Automated Service	35
3.2.2.	Type of Cybank Users	36
3.2.3.	Advantages of Cybank	36
3.2.4.	Detailed Features	38

3.2.4.1. Selling on the Web	38
3.2.4.2. Buying on the Web	39
3.2.4.3. Security of Cybank	39
3.2.4.4. Multiple Account	40
3.2.4.5. Portability of Account	40
3.2.4.6. Phonecash	40
3.2.4.7. Secure Relay Proxy (SRP)	40
3.2.4.8. Secure Document Relay (SDR)	41
3.3 Cybank's Operation	41
3.4 Problems Faced by Cybank's Management	42
3.5 Pilot Performance Study on Cybank	42
3.5.1. Importance of the Study	43
3.5.2. Objective of Pilot Study	44
3.5.3. Generation of Survey Questions	44
3.5.4. Conducting the Pilot Study	45
3.5.5. Method of Analysis	46
3.5.6. Result and Interpretation	46
3.5.6.1. Result and Interpretation for Part One	46
3.5.6.2. Result and Interpretation for Part Two until Six	48
3.5.6.3. Result and Interpretation for Part Seven	51
3.5.6.4. Result and Interpretation for Part Eight	52
3.5.6.5. Average Percentage of Each Grouping of Agrees, Neutrals and Disagrees for Each Part	53
3.5.6.6. Total Respondent's Level of Agreeableness towards Cybank's Services	54
3.6 Conclusion	56

## **CHAPTER 4: APPLIED SIMULATION WORKS AND GENERATION OF PROCESS FLOW CHARTS**

4.1	Introduction	57
4.2	Advances in Simulation	57
4.3	Challenges in Simulation Modeling	58
4.4	Simulation Modeling Process	59
4.4.1.	Problem Definition	59
4.4.2.	Setting of Objectives and Overall Project Plan	60
4.4.2.1.	Simulation Team	61
4.4.2.2.	Information Needed as Input Data	62
4.4.2.3.	Precise Criteria Needed to Carry Out the Research	62
4.4.2.4.	Location of Research	63
4.4.2.5.	Time Schedule	64
4.4.3.	Model Building	64
4.4.3.1.	Defining the System	64
4.4.3.2.	Formulating the Conceptual Model	65
4.4.3.3.	Preliminary Experimental Design	72
4.4.4.	Preparation of Input Data	72
4.4.5.	Coding Process	74
4.4.6.	Verification and Validation	75
4.4.7.	Final Experimental Design	75
4.4.8.	Run Experiments	76
4.4.9.	Analyze and Interpret	76
4.4.10.	Implementation and Documentation	76
4.5	Conclusion	77

## **CHAPTER 5: STATISTICAL INPUT ANALYSIS**

5.1	Introduction	78
5.2	Analyzing the Input Data	78
5.2.1	Using the ARENA® Software	78
5.2.1.1	The Chi-Square Tests	79
5.2.1.2	The Kolmogorov-Smirnov Tests	79
5.3	Analysis Structure in Data Selection	80
5.3.1	Open Account Processes	81
5.3.2	Add Cash Processes	84
5.3.3	Purchasing Processes	87
5.3.4	Transfer E-Cash Processes	89
5.3.5	Withdrawal Processes	92
5.4	Conclusion	94

## **CHAPTER 6: BUILDING, VERIFYING AND VALIDATING THE CYBANK MODEL**

6.1	Introduction	95
6.2	Objectives of the Model	95
6.3	Model Development	96
6.3.1	Dividing the System into Logical Subsystems	97
6.3.2	Defining Every Entity That Flows Through A System	97
6.3.3	Defining the Stations for Every Process Done Onto Every Entity.	97
6.3.4	Defining the Basic Flow Patterns of Entities Through the Stations Using Flow Diagrams.	99
6.4	ARENA® Software	99
6.4.1	ARENA® Modules	100
6.5	Creating the Logic Model of Cybank	103
6.5.1	Open Account Sub Model	103

6.5.2	Add Cash Sub Model	104
6.5.3	Purchasing Sub Model	106
6.5.4	Transfer Sub Model	107
6.5.5	Withdrawal Sub Model	108
6.5.6	Integrated Cybank Model	109
6.6	Refining the Cybank Model	109
6.6.1	Animation	110
6.6.2	Statistics	112
6.6.3	Dynamics Plots	112
6.7	Verification of the Model	113
6.8	Validation of the Model	114
6.9	Conclusion	116

## **CHAPTER 7: OUTPUT ANALYSIS & MODEL EXPERIMENTATION**

7.1	Introduction	118
7.2	Output Analysis	118
7.2.1	Type of Simulation Model	118
7.2.2	Preparing for Analysis	119
7.2.3	Analyzing the Outputs	120
7.2.4	Conveying Results	122
7.2.4.1	Analysis of External Performance Variables	122
7.2.4.2	Analysis of Internal Performance Variables	125
7.3	Model Experimentation	130
7.3.1	Experimental Design	130
7.3.1.1	Scenario 1	130
7.3.1.2	Scenario 2	132
7.3.1.3	Scenario 3	134

7.3.1.4 Scenario 4	136
7.3.2 Comparison of Results	138
7.4 Recommendation and Discussion	140
7.5 Conclusion	141

## **CHAPTER 8: CONCLUSION**

8.1 Introduction	143
8.2 Chapter Reviews	144
8.3 Challenges of the Research	146
8.3.1 Time Consuming Factor	146
8.3.2 Monetary Cost Factor	148
8.3.3 Human Behaviour	149
8.4 Further Research	150

<b>REFERENCES</b>	151-157
-------------------	---------

## **APPENDICES**



## **LIST OF FIGURES**

- Figure 1.1 – Cybank’s General Flow
- Figure 2.1 – Entities in the IPS Industry
- Figure 2.2 – The IPS System Operation
- Figure 2.3 – Classification of Performance Evaluation Technique
- Figure 3.1 – Relationship between Services in Cybank
- Figure 4.1 – The Simulation Modeling Process
- Figure 4.2 – Process Flow Chart of Cybank’s Open Account Process (from  
Cybank’s Website)
- Figure 4.3 – Process Flow Chart of Cybank’s Adding Cash Process  
(through Credit Card)
- Figure 4.4 – Process Flow Chart of Cybank’s Adding Cash Process  
(through Bank Transfer, Cheque, Cash)
- Figure 4.5 – Process Flow Chart of Cybank’s Purchasing Process
- Figure 4.6 – Process Flow Chart of Cybank’s Transfer Fund Process
- Figure 4.7 – Process Flow Chart of Cybank’s Withdrawal Fund Process
- Figure 5.1 – Distribution Summary of the Whole Open Account Process
- Figure 5.2 – Distribution Summary of the Whole Add Cash Process
- Figure 5.3 – Distribution Summary of the Whole Purchasing Process
- Figure 5.4 – Distribution Summary of the Whole Transferring E-Cash Process
- Figure 5.5 – Distribution Summary of the Whole Withdrawal Process
- Figure 6.1 – Relationship between Entities in IPS Industry
- Figure 6.2 – Snapshot of the Open Account Sub Model
- Figure 6.3 – Snapshot of the 1<sup>st</sup> subsequent process of the Add Cash Sub Model
- Figure 6.4 – Snapshot of the 2<sup>nd</sup> subsequent process of the Add Cash Sub Model
- Figure 6.5 – Snapshot of the 3<sup>rd</sup> subsequent process of the Add Cash Sub Model
- Figure 6.6 – Snapshot of the Purchasing Sub Model
- Figure 6.7 – Snapshot of the Transfer E-Cash Sub Model
- Figure 6.8 – Snapshot of the Withdrawal Sub Model
- Figure 6.9 – Snapshot of the Integrated Cybank Simulation Model

## **LIST OF TABLES**

Table 2.1	– Operational Process of an IPS
Table 2.2	– Major Players of the IPS Industry
Table 2.3	– Performance Variables
Table 2.4	– Purpose of Using Simulation
Table 2.5	– Advantages and Disadvantages of Simulation
Table 2.6	– Simulation Capabilities and Limitations
Table 3.1	– Advantages of Cybank for its Customers
Table 3.2	– Advantages of Cybank for its Merchants
Table 4.1	– Type, Source and Collected Data
Table 5.1	– Input Analysis Summary on the Distribution of the Open Account Processes
Table 5.2	– Input Analysis Summary on the Distribution of the Add Cash Processes
Table 5.3	– Input Analysis Summary on the Distribution of the Purchasing Processes
Table 5.4	– Input Analysis Summary on the Distribution of the Transfer E-Cash Processes
Table 5.5	– Input Analysis Summary on the Distribution of the Withdrawal Processes
Table 6.1	– Stations in Cybank
Table 6.2	– Modules used to build the Cybank Simulation Model
Table 6.3	– Animation Concepts in Arena
Table 6.4	– Simulated Throughput of 7 days and 12 Replications
Table 6.5	– Difference of Throughput by Cybank Model & System
Table 7.1	– Current Level of Average Simulated Throughput and Processing Time
Table 7.2	– List of Reported Modules

## **LIST OF APPENDICES**

Appendix 3.1	- Sample of Generated Survey Question
Appendix 3.2	- Result of the Pilot Survey
Appendix 3.3a	- Total of Each Answer According to the Likert Scale
Appendix 3.3b	- Percentage on Each Answer According to the Likert Scale
Appendix 4.1	- Specification of Hardware Used
Appendix 4.2 – 4.7	- 5 Generated Process Flow Chart
Appendix 4.8	- Intention Letter From Oxford Media Sdn Bhd
Appendix 5.1	- Chi-Square And Kolmogorov-Smirnov Test
Appendix 5.2	- Seven Days Open Account Data Collected
Appendix 5.3	- Open Account Timing Charts
Appendix 5.4	- Seven Days Add Cash Data Collected
Appendix 5.5	- Seven Days Purchase Data Collected
Appendix 5.6	- Seven Days Transfer Data Collected
Appendix 5.7	- Seven Days Withdrawal Data Collected
Appendix 6.1	- Layout of Built Cybank Model
Appendix 7.1	- Generated Report on Cybank's Actual Performance (Simulated Model)
Appendix 7.2	- Generated Report on Scenario 1 Changes
Appendix 7.3	- Generated Report on Scenario 2 Changes
Appendix 7.4	- Generated Report on Scenario 3 Changes
Appendix 7.5	- Generated Report on Scenario 4 Changes
Appendix 7.6	- Comparison of Utilization Value of each Resources
Appendix 7.7	- Comparison of Queue Time Value at each Resources
Appendix 7.8	- Comparison of Queue Length Value at each Resources

## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Background**

The Internet, which is a powerful medium for digital communication, has made a tremendous impact on our individual lifestyles and way of life. Penetration of knowledge in the Internet field is acknowledged as a vital dynamism that can help a nation excel in administration, management, social development, economy and other areas. This is because the Internet has dramatically evolved from being a means of conveying information to being a dynamic platform of communicating and doing businesses. In general, Internet has become the reality of today, the accepted new wave and way of integrating commercial services with the wizardry of an electronic marketplace. It has undoubtedly become a most dynamic business for small medium enterprises (SME) to compete at the international and global market.

Thus remarkable changes in the business world have given a rise to the 'Internet business' word where men trade everything on the Net and in the process promote and a better competitive edge in the business world. The Internet has empowered a stronger and faster developing economy in accelerating the rivalry of healthy competition through globalization and liberalization. In particular, the estimated number of Internet and personal computer (PC) penetration by Malaysians that is acquired from local Internet Service Providers (IPS) is 2.2 million users for year 2000 (Abdullah, 2001). This figure, demonstrates the growth of computer literacy level among Malaysians and serve our eloquent testimony of Malaysia's capability to compete in this knowledge-based economy (k-economy) era.

Today, the Internet is the most favored and efficient way for performing financial transactions. This inevitably gave a boost in the Internet Payment System (IPS) technology. Malaysians, who are versatile and knowledgeable of the Internet and IPS, would be poised to empower better efficiency, productivity and profitability in

The contents of  
the thesis is for  
internal user  
only

## REFERENCES

- Abdullah, O.Y. (2001). Multimedia Super Corridor – Malaysia's Move towards the Knowledge Economy. **Proceeding of Knowledge Management 2001 International Conference and Exhibition.**
- Advertising, Marketing and Electronic Commerce (1999). **Advertising, Marketing and Electronic Commerce.** Retrieved: March 2000, from site <http://www.ntu.edu.sg/library/advrtise.htm>.
- Banks, J. (2000). Simulation in the Future. **Proceedings of the 2000 Winter Simulation Conference.** J.A Joines, R.R.Barton, K.Kang and P.A. Fishwick (eds).
- Banks, J., Carson, J.S. and Nelson, B.L. (1996). **Discrete Event Systems Simulation,** 2nd Edition. New Jersey: Prentice Hall.
- Boling. B. and Laymon, M. (1986). The Model Master Factory Modeling System Tutorial. **Proceedings of the 1986 Winter Simulation Conference.** A.Thesen, H.Grant, W.David Kelton (eds).
- Box, G.E.P. Hunter, W.G and Hunter, J.S. (1978). **Statistics for Experimenters: An Introduction to Design, Data Analysis and Model Building.** New York: John Wiley
- Brately. P., Fox B.L. and Schrage L.E. (1987). **A Guide to Simulation,** 2nd Edition. New York: Springer-Verlag.
- Brown. J.C., Chandy, K.M., Brown, R.M., Keller T.W., Towsley. D.F. and Dizzly. C.W. (1975). Hierarchical Techniques for the Development of Realistic Models of Complex Computer Systems. **Proceedings of IEEE,** 62(6), 966-975.
- Cady, J. and Howarth, B. (1990). **Computer Systems Performance Management and Capacity Planning.** Prentice Hall of Australia Pty, 24 –27.
- Carson. J.S. (1992). Modelling. **Proceedings of the 1992 Winter Simulation Conference.** J.J.Swain, D.Goldzman, R.C.Crain and J.R.Wilson (eds).
- Carson. J.S. (1986). Convincing User's of Model's Validity is Challenging Aspect of Modeler's Job. **Industrial Engineering.** June: 77.
- Centero, M.A. and Carillo, M. (2001). Challenges of Introducing Simulation as a Decision Making Tool. **Proceedings of the 2001 Winter Simulation Conference.** B.A Peters, J.S Smith, D.J.Medeiros and M.W Rohrer (eds).
- Christos, G.P., Christos, G.C. and Gong, W-B. (2000). Model Abstraction for Discrete Event Systems Using Neural Networks and Sensitivity Information.

- Proceedings of the 2000 Winter Simulation Conference.** J.A. Joines, R.R.Barton, K.Kang and P.A. Fishwick (eds).
- Davies, R. (2001). **Electronic Money, or E-Money, and Digital Cash.** Retrieved: September 2001, from site <http://www.ex.ac.uk/~RDavies/arian/emoney.html>.
- Delaney, B. (2000). **Direct interview** at the Oxford Media Sdn. Bhd. office in Kuala Lumpur on September 8.
- Fishman G.S. (1978). **Principles of Discrete Event Simulation.** New York: John Wiley & Sons.
- Flatto, J. and Gardner, L.L. (2000). Using Information Generated by a Discrete Event Simulation to Evaluate Real Options in a Research and Development Environment. **Proceedings of the 2000 Winter Simulation Conference.** J.A. Joines, R.R. Barton, K.Kang, and P.A. Fishwick (eds).
- Fu, M/C. and Hu, J-Q. (1997). **Conditional Monte Carlo Gradient Estimation and Optimization Applications.** Massachusetts: Kluwer Academic Publisher.
- Gerlach, D. (2000). Put Your Money Where Your Mouse Is. **PC World.** March issue, 191-199.
- Ghosh, S. (1998). Making Business Sense of the Internet. **Harvard Business Review.** March-April issue, 126-35.
- Goldsman, D. and Tokol, G. (2000). Output Analysis Procedures for Computer Simulations. **Proceedings of the 2000 Winter Simulation Conference.** J.A. Joines, R.R.Barton, K.Kang and P.A. Fishwick (eds).
- Gosselin, D. (2000). Internet, New York: **DDC Publications.** Retrieved: March 2000, from site: <http://www.pe.utexas.edu/Dept/Academic/Courses/SP2001/TC357/chapters/ec on.htm# com>.
- Gulati, S. and Malcolm, S.A. (2001). Call Center Scheduling Technology Evaluation Using Simulation. **Proceedings of the 2001 Winter Simulation Conference.** B.A Peters, J.S Smith, D.J.Medeiros and M.W Rohrer (eds).
- Gurau, C., Ranchhod, A. and Hackney, R. (2001). Internet Transactions and Physical Logistics: Conflict or Complimentary". **Logistics Information Management.** 14(1/2). 33-43.
- Hahn, G. (1981). An Overview of Tools for Automated Statistical Graphics. G.E.Corp., **R&D Technical Report 81CRD024.**
- Hammer, M. and Champy, J. (1993) **Reengineering the Cooperation.** New-York: Harper Collins.
- Harrel, C.R. and Tumay, K. (1994). **Simulation Made Easy – A Manager's Guide.** Industrial Engineering and Management Press, Institute of Industrial Engineers, Norcross.
- Healy, K. (1986). Cinema Tutorial. **Proceedings of the 1986 Winter Simulation Conference.** A.Thesen, H.Grant, W.David Kelton (eds).

- Hornby, H.S. (2000). **Oxford Advanced Learner's Dictionary of Current English**. Sixth Edition. New York: Oxford University Press.
- IDC (1998). The Global Market Forecast for Internet Usage and Commerce. **IDC**: June.
- Ikhwan I.H. and Tahar R.M. (2001a). Issues and Challenges of the Malaysian Economy: From the Perspective of Internet Payment System. **Proceeding Pameran Penyelidikan dan Pembangunan IPTA**, Putra World Trade Centre, Dewan Tun Dr. Ismail.
- Ikhwan, I.H. and Tahar, R.M. (2001b). Efficiency Issues to Improve Internet Payment Systems. **Proceeding of the National Conference on Management Sciences 2001**, Universiti Putra Malaysia.
- Ikhwan, I.H. and Tahar, R.M. (2001c). Evaluating Internet Payment System's Performance Using Simulation. **Abstract Book of the International Conference on Intelligent Agents, Web Technologies and Internet Commerce**, Las Vegas.
- Ikhwan, I.H. and Tahar, R.M. (2001d). Customized Simulation Method To Build An Internet Payment System Model For Performance Evaluation. **Proceeding of the Middle East Simulation Management 2001 (MESM2001) Conference**, SCS-Europe BVBA, Amman University, Amman. Internet Section, 45.
- Ikhwan, I.H. and Tahar, R.M. (2001e). Using Simulation To Evaluate Performance Factors of Internet Payment System: A Case Study on Cybank. **Proceedings of the International Conference on Information Technology and Multimedia**. Universiti Tenaga Nasional.
- Interagency Working Group (1999). The 21st Century Revolution: High End Computing - Infrastructure and Applications, Supplement to the President's FY 2001 Budget, National Science and Technology Council. **National Coordination Office for Computing, Information and Communications Report**.
- Jain, R. (1991). **The Art of Computer Systems Performance Analysis: Techniques for Experimental Design, Measurement, Simulation and Modeling**, Canada: John Wiley & Sons.
- Jain, R. and Routhier, S. (1986). Packet Trains: Measurements and a New Model for Computer Network Traffic. **IEEE Journal on Selected Areas in Communications**. 4(6), 986-995.
- Kelton, W.D., Sadowski, R.P. and Sadowski, D.A. (1998). **Simulation with Arena**. International Editions 1998, WCB/McGraw-Hill.
- Kleijnen, J.P.C. (1982). Statistical Aspects of Simulation: An Updated Survey. **Statistica Neveerlandica** 36, 165-186.
- Kleijnen, J.P.C. (1987). Simulating with Too Many Factors: Review of Random and Group-Screening Design. **European Journal of Operations Research**, 31(1).
- Larry, L. (1997). Seven Habits of Highly Successful Input Modelers. **Proceedings of the 1997 Winter Simulation Conference**. S. Andradottir, K.J. Healy, D.H. Withers and B.L.Nelson (eds).



- Law, A.M. (1983). Statistical Analysis of Simulation Output Data. **Operations Research**, 31, 983-1029.
- Law, A.M. and Kelton, W.D. (1991). **Simulation Modeling and Analysis**, 2nd Edition. New York: McGraw Hill.
- Law, A.M. and McComas, M.G. (1988). How Simulation Pays Off. **Manufacturing Engineering**, 23(3), 20-23.
- Lindemann, C. (1998). **Performance Modeling with Deterministic and Stochastic Petri Nets**. New York: John Wiley & Sons Ltd.
- Low, D. (2000). Online Shopping Survey in Malaysia. **Radio Era**, 103.3 FM, August 13.
- Lowery, J.C. (1998). Getting Started in Simulation in Healthcare. **Proceedings of the 1998 Winter Simulation Conference**. D.J Medeiros, E.F. Watson, J.S. Carson and M.S. Manivannan (eds).
- Lynch, D.C. and Lundquist, L. (1996). **Digital Money. The New Era of Internet Commerce**. John, Wiley & Sons, Inc., pg 1-285
- Madhava, D.R. and Wilsey, P.A. (2000) Dynamic Component Substitution In Web-Based Simulation, **Proceedings of the 2000 Winter Simulation Conference**. J.A. Joines, R.R. Barton, K.Kang, and P.A. Fishwick, eds.
- Mayban2U.com (1999). Maybank Introduces First-ever Bill, View and Pay Service Via Internet. **Maybank's Press Release**.
- McKerrow, P. (1988) Performance Measurement on Computer Systems: A Formulation of Performance Management. Great Britain: **International Computer Science Series**, 3-5.
- Mecklermedia, (2000). **The Electronic Commerce Guide**. Retrieved: January 2001, from site: <http://ecommerce.internet.com>.
- Mefford, R.N. (1993). Improving Service Quality: Learning From Manufacturing. **International Journal of Production Economics**, 30, 399-413.
- Mehta, A. (2000). Smart Modeling – Basic Methodology and Advanced Tools. **Proceedings of the 2000 Winter Simulation Conference**. J.A.Joines, R.R.Barton, K.Kang and P.A.Fishwick (eds).
- Meuter, M.L., Ostrom, A.L., Roundtree, R.I., and Bitner, M.J. (2000). Self-service Technologies: Understanding Customer Satisfaction with Technology-Based Service Encounters. **Journal of Marketing**, October. 48-52.
- Jun, M. and Cai, S. (2001). The Key Determinants Of Internet Banking Service Quality: A Content Analysis. **International Journal of Bank Marketing**, 19(7), 276 – 291.
- Moggie, L. (1999). Capitalize on Internet Commerce Payment Systems to Enhance Business Competitiveness. **The Star**, Sept 9.
- Mols, N.P. (2000). The Internet And Services Marketing - The Case Of Danish Retail Banking. **Internet Research: Electronic Networking Applications and Policy**, 10 (1), 7-18.

- Morris, M.F. and Roth, P.F. (1982). **Tools and Techniques: Computer Performance Evaluation for Effective Analysis**. New York: Van Nostrand Reinhold.
- Moskow, M (2000). Press Release - Explores Impact Of E-Commerce. **Federal Reserve Bank of Chicago Releases 1999 Annual Report**. Retrieved: April 2000, from site <http://www.chicagofed.org/newsandevents/pressreleases/2000/pr0403200.cfm>.
- Musselman, K.J (1992). Conducting a Successful Simulation Project. **Proceedings of 1992 Winter Simulation Conference**. J.J. Swain, D.Goldsman, C.Crain and J.R. Wilson (eds), 115-121.
- Mustaffa, S.H. (1996). Pengenalan kepada WWW. **Seminar Internet**, 6/4/1996, Alor Setar, Kedah, 29-38.
- Naylor, T.H., Balintfy, J.L., Burdick, D.S. and Chu, K. (1966). **Computer Simulation Technique**. John Wiley.
- Nutt, G.J. (1975). Tutorial: Computer System Monitors. **IEEE Computer**. 8(11), 51-61.
- Papows, J. (1998). Market Leadership in the Information Age. **Enterprise.com**. Lotus Development Corporation. Perseus Books, pg 1-240.
- Parsons, J. (2001). **Computer Security and Internet Commerce**. Retrieved: January 2001, from site <http://www.ocf.berkeley.edu/~jparsons/pistis.html>
- Pawlikowski, K. and Kreutzer, W. (2000). Integrating Modelling and Data Analysis in Teaching Discrete Event Simulation. **Proceedings of the 2000 Winter Simulation Conference**. J.A Joines, R.R.Barton, K.Kang and P.A. Fishwick (eds).
- Peterson, R.A., Balasubramanian, S., and Bronnenberg, B.J. (1997). Exploring the Implications of the Internet for Consumer Marketing. **Journal of the Academy of Marketing Science**, 25(4), 329-46.
- Phau, I. and Sui, M.P. (2000). Factors influencing the types of products and services purchased over the Internet. **Internet Research: Electronic Networking Applications and Policy**, 10(2), 102-113.
- Phelps, R.A., Parson, D.J., and Siprelle, A.J. (2000). The SDI Industry Product Suite: Simulation from The Production Line To The Supply Chain. **Proceedings of the 2000 Winter Simulation Conference**. J.A. Joines, R.R. Barton, K.Kang, and P.A. Fishwick (eds), U.S.A: Simulation Dynamics.
- Pidd, M. (1994). An Introduction to Computer Simulation. **Proceeding of the 1994 Winter Simulation Conference**. J.D.Tew, S.Manivannan, D.A. Sadowski and A.F Seila (eds.), 62-67.
- Press Release Federal Reserve Bank of Chicago (1999). Explores Impact Of E-Commerce. **Federal Reserve Bank of Chicago Releases 1999 Annual Report on March 2000**.
- Pritsker, A.A.B. (1986). GASP 1977. **Encyclopedia of Computer Science and Technology**. J.Belzer, A.G.Holzman and A.Kent (eds), 8, New York: Dekker.

- Rabbath, C.A., Abdoune, M. and Belanger, J. (2000). Effective Real-Time Simulations of Event Based Systems. **Proceedings of the 2000 Winter Simulation Conference**. J.A Joines, R.R.Barton, K.Kang and P.A.Fishwick (eds).
- Robinson, S. (1994). **Successful Simulation: A Practical Approach to Simulation Projects**. UK: Mc-Graw Hill.
- Robinson, S. (1999). Three Sources of Simulation Inaccuracy (and How to Overcome Them). **Proceeding of the 1999 Winter Simulation Conference**. P.A Farrington, H.B.Nembhard, D.T.Sturrock and G.W., (eds).
- Robinson, S. (1995). **An Heuristic Technique for Selecting the Run Length of Non-Terminating Steady State Simulations**. *Simulation* 65 (3): 170-179
- Rose, S. (2000). The Truth about Online Banking. **Money**, 29(4), 114-122.
- Sanchez, S.M. (1999). ABC's of Output Analysis. **Proceedings of the 1999 Winter Simulation Conference**. P.A Farrington, H.B.Nembhard, D.T.Sturrock and G.W., (eds).
- Sargent, R.G. (1996). Verifying and Validating Simulation Models. **Proceeding of the 1996 Winter Simulation Conference**. J.M.Charnes. (ed).
- Schruben, L.W. (1982). Detecting Initialization Bias in Simulation Output. **Operations Research**, 30, 556-568.
- Schruben, L.W. (1983). Confidence Interval Estimation Using Standardized Time Series. **Operations Research**, 31, 569-590.
- Schruben, L.W. 1987. Using Simulation to Solve Problems: A Tutorial on the Analysis of Simulation Output. **Proceedings of the 1987 Winter Simulation Conference**. A.Thesen, H.Grant, W.David Kelton (eds).
- Scott, D.S., Eugene, P.P. and Lyn, R.W. (2001). Case Study in Modeling and Simulation Validation Methodology. **Proceedings of the 2001 Winter Simulation Conference**. B.A Peters, J.S Smith, D.J.Medeiros and M.W Rohrer (eds).
- Seila, A.F. (1990). Output Analysis for Simulation, **Proceedings of the 1990 Winter Simulation Conference**. Osman Balci, Randall P. Sadowski, Richard E. Nance (eds), 49-54.
- Seila, A.F. (1995). Introduction to Simulation. **Proceeding of the 1995 Winter Simulation Conference**. Arlington, Virginia, 3-6 December. C.Alexopoulos, K.Kang, W.R Lilegdon and D.Goldsman (eds), 7-14.
- Shannon, R.E. (1998), Introduction To The Art And Science Of Simulation. **Proceedings of the 1998 Winter Simulation Conference**. DJ Medeiros, E.F. Watson, J.S. Carson and M.S. Manivannan (eds).
- Shariffadeen, M.A. (2000). Perniagaan Perlu Sedia Asas Global. Press Release by The Secretary of the National Information Technology Council (NITC), Tengku Datuk Dr. Mohd Azzman Shariffadeen. **Utusan Malaysia**, June 4.
- Shon, T.H. and Swatsman, P.M.C. (1998). Identifying Effectiveness Criteria for Internet Payment Systems. **MCB Internet Research and Colon: Electronic Networking Applications and Policy**, 8 (3).

- Shostack, G.L. (1985). Planning the Service Encounter, Czepiel, J.A., Solomon, M.R., Surprenant, C.F. (eds), **The Service Encounter**, Lexington: Lexington Books, 243-54. Retrieved: January 2001, from site <http://emerald.catchword.com/cgi-bin/emerald.pl?mcbid=0320190702.sgm-000000-000000-32>
- Shrader, S. (2001). Simulation in Government, Validating Business Strategy. **Proceedings of the 2001 Winter Simulation Conference**. B.A Peters, J.S. Smith, D.J. Medeiros and M.W.Rohrer (eds).
- Singer, R. and Gasparatos, A. (1994). Help Desks Hear Voice. **Software Magazine**. February: 24-26.
- Steinfeld, C. (1995). **Journal of Computer-Mediated Communication: Issue on Electronic Commerce**. Retrieved: December 2000, from site <http://www.ascusc.org/jcmc/vol1/issue3/vol1no3.html>
- Svobodova, L. (1976). **Computer Performance Measurement and Evaluation Methods: Analysis and Application**. New York: Elsevier.
- Swart, W. and Donno, L. (1981). Simulation Modeling Improves Operations, Planning and Productivity for Fast Food Restaurants. **Interfaces**, Vol 11: 35-47
- Temasek Polytechnic (1998). Internet shopping in Singapore. **Internet Research: Electronic Networking Applications and Policy**, Unpublished report.
- Tukey, P. (1987). A Data Analyst's View of Statistical Plots. **Bellcore Applied Research Area Technical Report**. 87-275.
- USA Federal Government (2001). **Office of Electronic Government**. Retrieved: February 2001, from site <http://ec.fed.gov>
- Utusan Megabait. (2000). Bayar Bil TNB Melalui Internet Ogos ini. **Utusan Megabait**. June 6, 2000: 7.
- Viswanadham, N. and Narahari, Y. (1992). **Performance Modeling of Automated Manufacturing Systems**. New Jersey: Prentice-Hall.
- Welch, P.D. (1983). **The Statistical Analysis of Simulation Results: Computer Performance Modeling Handbook**. ed. S. Lavenberg, Florida: Academic Press.
- Yarden, S. (1997). Evaluating the Performances of Electronic Commerce Systems. **Proceedings of the 1997 Winter Simulation Conference**. S. Andradottir, K.J. Healy, D.H. Withers and B.L.Nelson (eds).